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Predictors of micronutrient powder sachet coverage in Nepal

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Abstract

Many countries implement micronutrient powder (MNP) programmes to improve the nutritional status of young children. Little is known about the predictors of MNP coverage for different delivery models. We describe MNP coverage of an infant and young child feeding and MNP intervention for children aged 6–23 months comparing two delivery models piloted in rural Nepal: distributing MNPs either by female community health volunteers (FCHVs) or at health facilities (HFs). Cross-sectional household cluster surveys were conducted in four pilot districts among mothers of children 6–23 months after starting MNP distribution. FCHVs in each cluster were also surveyed. We used logistic regression to describe predictors of initial coverage (obtaining a batch of 60 MNP sachets) at 3 months and repeat coverage (≥2 times coverage among eligible children) at 15 months after project launch. At 15 months, initial and repeat coverage were higher in the FCHV model, although no differences were observed at 3 months. Attending an FCHV-led mothers' group meeting where MNP was discussed increased odds of any coverage in both models at 3 months and of repeat coverage in the HF model at 15 months. Perceiving ≥1 positive effects in the child increased odds of repeat coverage in both delivery models. A greater portion of FCHV volunteers from the FCHV model vs. the HF model reported increased burden at 3 and 15 months (not statistically significant). Designing MNP programmes that maximise coverage without overburdening the system can be challenging and more than one delivery model may be needed.

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Conflicts of interest

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, UNICEF, or the Government of Nepal. The authors have no conflicts of interest to declare.

Contributions

MEDJ: Study design, data analysis, interpretation, writing and approval of manuscript. KRM: Study design, data analysis, interpretation, writing, approval of manuscript. GRS: Interpretation, revision and approval of manuscript. SB: Interpretation, revision and approval of manuscript. PD: Interpretation, revision and approval of manuscript. CGP: Study design, data analysis, interpretation, and approval manuscript.

Keywords

coverage; micronutrient powder; nutritional supplementation; monitoring; delivery models; children's nutrition; anaemia; iron deficiency

Introduction

Anaemia and iron deficiency are pervasive worldwide, with 273 million children 6–59 months of age suffering from anaemia in 2011 (Stevens *et al*. 2013). Micronutrient interventions are recognised as highly cost-effective public health interventions (Copenhagen Consensus Expert Panel 2008, 2012). Micronutrient powder (MNP) is sachets of vitamins and minerals that are mixed into semi-solid food right before eating. The World Health Organization recommends home fortification with MNP for children 6–23 months of age to improve anaemia and iron status (World Health Organization 2011). As of 2013, more than 40 countries were implementing preventive MNP interventions to improve anaemia and micronutrient status (UNICEF 2014). While the efficacy of MNP interventions to improve anaemia and iron status is well established in controlled trial settings, the public health programmatic experience is still growing (De-Regil *et al*. 2011; Rah *et al*. 2012; Serdula *et al*. 2013).

The number of MNP intervention programmes has increased rapidly in recent years, and there is considerable variety in their design and delivery, with most delivering MNP through routine public distribution channels (Jefferds *et al*. 2013). Child health days and similar outreach events can support high and equitable coverage for some interventions, especially in low capacity settings (Palmer *et al*. 2013), but due to the behaviour change communication and counselling required, few MNP programmes include MNP distribution as part of biannual events (Jefferds *et al*. 2013). Drawing on social ecological theories of health promotion (Stokols 1996), the Information, Motivation, Behavioral Skills (IMB) theory (Fisher & Fisher 1992; Fisher *et al*. 2008), and practice-based evidence, the *WHO/CDC logic model for vitamin and mineral interventions in public health programmes* outlines expected intervention processes and shows that establishing and maintaining high coverage of batches of MNP requires both well-functioning logistics to ensure product availability – including effective MNP supply management, transportation and distribution – and effective behaviour change strategies aimed at promoting knowledge, skills and sustained MNP demand and motivation for use by participants (De-Regil *et al*. 2014). Despite growing public health investment and programme growth, little is known about how different delivery models influence MNP coverage. With the increasing number and scale of MNP interventions worldwide, it is critical to understand which models are most effective in different settings (dePee *et al*. 2013).

The purpose of this paper is to describe coverage of batches of MNP and factors influencing coverage for two MNP delivery models piloted in an integrated infant and young child feeding (IYCF) and MNP project among children 6–23 months of age in rural Nepal. We also describe the perceived burden of implementing the programme on female community health volunteers (FCHVs).

Materials and methods

Pilot project integrating MNP into an infant and young child feeding programme

The MNP sachet distribution and behaviour change strategies were added to an existing IYCF programme that included education and counselling about recommended breastfeeding and complementary feeding practices. The pilot was designed to distribute 60 MNP sachets to all children 6–23 months of age every 6 months (a total of 180 sachets per child aged 6–23 months). Caregivers (usually mothers, and referred to as mothers in this paper) were instructed to provide one sachet daily for 60 days and, if they stopped for any reason, to start again until the sachets were finished. In 6 months, they should return to get the next batch. The MNP was locally branded as Baal Vita and included 15 vitamins and minerals.

Two delivery models for MNP distribution were piloted in rural areas of selected districts. Both models involved FCHV (who were generally unpaid local volunteers from the community who provided various health-related services, including IYCF support). When designing the delivery models for the pilot, there was a concern that FCHVs were already overworked and that it would be too burdensome for them to also distribute MNP. As a result, FCHV delivered the behaviour change support in both models, but routinely distributed MNP sachets in only one model. MNP were distributed routinely either through FCHV in the community (FCHV model) or through the health facilities (HF model), where families had to travel to the nearest health facility to get MNP. Health facility staff also supported behaviour change in both models but, because of MNP distribution in facilities, families in the HF model were expected to have more interaction with health facility staff regarding MNP compared with families in the FCHV model. All other aspects of the two intervention delivery models, strategies and content were designed to be identical.

In both models, health facility staff and FCHV were trained prior to the start of the pilot on the intervention and their primary roles in delivering the behaviour change strategies. The aims of the behaviour change component focused on creating an enabling environment and increasing caregivers (primarily mothers) knowledge and skills which would influence their experiences, acceptability and motivation to improve key IYCF practices, collect the MNP every 6 months, practise appropriate MNP preparation and use, and have the children consume all of the MNP from each batch obtained (Stokols 1996; Fisher *et al*. 2008). The behaviour change strategy included distributing an MNP brochure and a reminder card for each MNP distribution in both models. Both the brochure and the reminder card included key messages describing MNP and the correct MNP preparation and use, which were meant to support maternal knowledge, skills and motivation for MNP coverage, and sustained intake adherence. The reminder card also included dates showing MNP receipt and the date for families to get the next batch of 60 MNP sachets, as well as places to mark after feeding the child food mixed with MNP each day; this tool was meant to support mothers as memory aids for when to get the next batch of MNP, as well as to help establish an intake routine. The intervention was also advertised on the radio and billboards/banners and through other branded promotional strategies (e. g. on clocks and stickers given to FCHV). The radio advertisement included a mother talking about how and why to use MNP during a

usual day in her life, and the radio advertisement and billboards/banners included messages about MNP, appropriate preparation and use, and where to get more information. Each FCHV received an IYCF/MNP flip chart to use as a teaching aid, which included information on anaemia, IYCF, hygiene and sanitation, early childhood development and described MNP and appropriate MNP preparation and use. FCHVs are expected to hold mothers' group meetings every month on various topics, and in the behaviour change strategy, one meeting was used to launch the IYCF/MNP intervention in each community.

Eighty-three per cent of the population of Nepal lives in rural areas. The country has a diverse geography including three main ecozones: plains, hills and mountains (Himalayas). The elevations range from 90 to over 8800 m, with 50% of the population living in the plains, 43% in the hills and 7% in the mountains. Households are densely spaced in the plains and parts of the hills, whereas in other parts of the hills and the mountains above 2000 m, the distances between houses are much greater (Ministry of Health and Population Nepal, New ERA & ICF International Inc. 2012). Recognising the importance of variations in the geography of Nepal, both distribution models were piloted in each ecozone. In the plains ecozone, Rupandehi (FCHV model) and Parsa (HF model) districts participated and, in the hills, Palpa (FCHV model) and Makwanpur (HF model) districts participated; surveys were not collected in the two pilot districts in the mountains ecozone.

Surveys of households and FCHVs

Cross-sectional household surveys representative of children 6–23 months of age were collected in each of four pilot districts during October and November 2011 as part of programme monitoring of this public health intervention; UNICEF Nepal funded an external agency to conduct the surveys. Because there was a staggered start to the programme, these data were collected 3 months after programme roll-out in Rupandehi and Parsa districts (plains) and 15 months after programme roll-out in Makwanpur and Palpa districts (hills).

Proportion-to-size population sampling was used to select 30 clusters from rural areas of each district. In each cluster, a census was carried out and 12 children 6–23 months of age were randomly selected; their mothers were invited to participate in an interview (360 interviews per district/survey). There was no replacement of clusters, for refusal to participate in interviews, or for fewer than 12 eligible children in a cluster. In addition to the household surveys, in each selected cluster, every FCHV (usually one per cluster but sometimes more) was invited to participate in an FCHV interview. The response rate among mothers in the 3-month surveys collected in the plains was 100% in the FCHV model and 93% in the HF model, and for the 15-month survey in the hills, the response rates were 96% and 86%, respectively. The response rate for the FCHV invited to participate in the FCHV surveys was 100% in all surveys.

Participation in the interview was voluntary and women gave verbal informed consent that was witnessed and recorded. The Nepal Ministry of Health and Population approved the protocol and de-identified data were used for this secondary analysis.

Outcome variables: MNP coverage and repeat coverage

In the 3-month surveys, the outcome of interest was initial MNP coverage, defined as mother's report of ever obtaining a batch of 60 MNP sachets for her child. In the 15-month surveys, the outcomes were initial MNP coverage and MNP repeat coverage, defined as mother's report of receiving two or more batches of 60 MNP sachets for the eligible child (eligible children were ≥12 months of age who had received at least one previous batch of MNP sachets).

Predictor and covariate variables

Each mother reported her child's age and sex, her education level and household assets (used to develop a wealth quintile index). As a proxy indicator of knowledge and exposure to the programme, which might also influence motivation to give her child MNP, each mother was asked whether she knew of any consequences of anaemia (open-ended responses dichotomised into no vs. knows of at least one consequence). Mothers were expected to have participated in meetings or received programme materials and messages, which would influence their knowledge, skills and motivation to get and use MNP. They were asked if they had ever heard of MNP and, if yes, were questioned about whether they had experienced specific programme components (yes vs. no) that were used as proxies of exposure to the intervention package. Proxies included whether they had ever received information about MNP at a FCHV led mothers' group meeting, had ever heard the MNP radio advertisement, or had received an intervention brochure or reminder card. Mothers who responded that they had never heard of MNP were categorised as 'No' for attending a FCHV led mothers' group meeting about MNP or hearing the MNP radio advertisement. Among mothers who had given MNP to their children, additional questions were asked about direct experiences or perceptions of using MNP that might further influence motivation and demand for MNP. These included open-ended questions about any negative or positive effects of MNP in their children after use, which we categorised as perceived no positive effects vs. one or more positive effects, and perceived no negative effects vs. one or more negative effects. Mothers were asked if their children liked consuming food mixed with MNP (yes vs. no), how accessible were MNP (easily accessible vs. not), and reported round-trip time to pick up the last batch of 60 MNP sachets, which was dichotomised as <1 h round-trip vs. ≥ 1 h round-trip.

Statistical analysis

Data were analysed using SAS 9. 3 (SAS Institute Inc. , Cary, NC, USA) accounting for complex survey design. Chi-square tests were used to examine differences in coverage and other survey population characteristics by distribution model. A logistic regression model was developed for the surveys collected 3 months after the intervention start for the outcome of receiving a batch of 60 MNP sachets. There were two categories of predictor variables included in the model: child socio-demographic factors (age, sex) and proxies of intervention exposure that should have occurred prior to getting the first batch of 60 MNP sachets (attended a mothers' group meeting where FCHV discussed MNP, hearing the MNP radio advertisement and knowing consequences of anaemia). For the 15-month surveys, logistic regression was used to examine the odds of repeat coverage (limited to mothers of

children ≥12 months of age who reported obtaining at least one batch of MNP sachets). The same socio-demographic factors and proxies of intervention exposure variables were included as above, as well as additional variables related to MNP coverage and intake, including receiving an intervention brochure or a reminder card, perception of negative or positive effects in the child after MNP use, report of whether the child liked food mixed with MNP, and round-trip time to get the batches of MNP. Models were adjusted for maternal education and household wealth quintile. Chi-square tests were also used to examine differences in FCHV characteristics and work experiences in the FCHV surveys.

Results

Socio-demographic characteristics and any coverage in the plains, 3-month surveys

At the 3-month surveys, 49. 2% of mothers in the FCHV model were in the highest wealth quintile, and 36. 1% had a secondary education or higher, compared with 23. 5% and 12. 2%, respectively, in the HF model (Table 1).

Coverage of MNP at 3 months after programme implementation did not differ by delivery model (65. 0% in the FCHV model vs. 57. 4% in the HF model); nearly everyone who got a batch of MNP reported their child consumed at least one sachet (Table 1). Ever having heard about the MNP did not vary by delivery model, although having attended a mothers' group meeting where MNP was discussed was higher in the HF model. Among those who had ever heard of MNP, coverage was higher in the FCHV model (86. 7% vs. 68. 9%, $P < 0.001$). Similarly, more mothers who had heard of MNP reported that MNP were easily accessible in the FCHV model. Few mothers reported MNP stock being unavailable as a barrier to coverage ($n = 4$, FCHV model; $n = 15$ HF model; data not shown).

In both delivery models, older children (12–17 months and 18–23 months of age) had greater odds of obtaining a batch of 60 MNP sachets compared with children 6–11 months, at 3 months after programme implementation (Table 2). In the HF model, mothers of girls had approximately half the odds of getting MNP for their child compared with mothers of boys. In both delivery models, mothers who attended a mothers' group meeting where MNP was discussed had higher odds of obtaining MNP compared with those who did not attend (Table 2). In the FCHV model, hearing the MNP radio advertisement was associated with higher odds for MNP coverage compared with those not having heard it, and mothers who knew of one or more consequences of anaemia had greater odds of MNP coverage compared with mothers who did not know of any consequences.

Socio-demographic characteristics and any coverage, 15-month surveys

Among mothers in the surveys collected 15 months after implementation start, 52. 1% of those in the FCHV model and 22. 5% of those in the HF model had a secondary level of education or higher (Table 3). More than half of the mothers in the 15-month FCHV model and two-thirds of those in the HF model surveys were in the two lowest wealth quintiles.

Coverage of any MNP was higher in the FCHV model compared with the HF model (82. 5% vs. 51. 6%) in the 15-month surveys, as was ever hearing about the MNP (91. 3% vs. 74. 1%) (Table 3). Among those who had heard of MNP, coverage was higher in the FCHV

model (91. 1% vs. 69. 6%), and more mothers reported that MNP were easily accessible (95. 4% vs. 76. 3%). Few reported MNP stock being unavailable as a barrier to coverage (n = 3, FCHV model; n = 3, HF model; data not shown).

Repeat coverage, 15-month surveys

In a subsample of participants with children ≥12 months of age who reported ever getting at least one batch of MNP, repeat coverage (obtaining ≥2 batches of MNP) was higher in the FCHV model (51. 8% vs. 35. 3%). Among this subsample, > 92% of mothers reported MNP were easily accessible from both models.

Among those who obtained ≥2 MNP batches, 90. 0% of mothers in the FCHV model reported they had been reminded to get the next batch of MNP. Among those reminded, 93. 3% were reminded by FCHV, 6. 7% by a family member, and 3. 3% by health facility staff (multiple answers possible, data not shown). In the HF model, 68. 8% had been reminded to get the next batch of MNP. Among those reminded, 72. 7% were reminded by health facility staff, 45. 8% by FCHV, and 6. 1% by a family member (multiple answers possible, data not shown).

Among children ≥12 months of age whose mothers had previously obtained at least one batch of MNP, being 18–24 months of age was associated with increased odds of repeat MNP coverage compared with children 12–17 months of age in both models (Table 4). Likewise, in both models, mothers who perceived one or more positive effects of MNP after giving it to their children had increased odds of repeat coverage compared with mothers who reported there were no positive effects after MNP use. In the HF model, mothers who attended a mothers' group meeting had more than six times the odds of repeat coverage compared with mothers who did not attend.

FCHV characteristics and experiences with micronutrient powder distribution, 3-month surveys

In the FCHV surveys collected at 3 months, 72. 4% of volunteers in the HF model had no education compared with 47. 8% in the FCHV model (P = 0. 05) (Table 5). Volunteers in the HF model worked more days per week than those in the FCHV model; however, those in the FCHV model were more likely to work ≥5 hours per day. More volunteers in the HF model reported having discussed MNP with one or more mothers in the previous week than those in the FCHV model. While not statistically different (P = 0. 13), 23. 9% of volunteers in the FCHV model report needing more support to carry out work or not liking the added work of the IYCF/MNP programme compared with 10. 3% of volunteers in the HF model.

FCHV characteristics and experiences with micronutrient powder distribution, 15-month surveys

In the FCHV surveys collected after 15 months, 35. 3% of volunteers in the HF model had no education compared with 13. 8% in the FCHV model (P = 0. 05) (Table 5). There were no differences between the two distribution models in the average number of days worked as a volunteer the previous week, or in the proportion who worked an average of ≥5 h per day on FCHV duties. Although not statistically different (P = 0. 20), 56. 5% of volunteers in the

FCHV model reported needing more support to carry out work or not liking the added work of the IYCF/MNP program compared with 43. 5% in the HF model.

Discussion

Two MNP distribution models were piloted as part of an integrated IYCF/MNP intervention in rural Nepal. In the FCHV model, female volunteers routinely distributed MNP directly to families in their communities. This was expected to be the most convenient and effective distribution model for families, as it should have required the least amount of travel to get MNP to eligible children. However, FCHVs were already responsible for implementing the existing IYCF programme in communities, as well as other services, and there was concern that adding both the behaviour change component and the routine distribution of MNP to the FCHV scope of work might be too burdensome. The HF distribution model was also piloted, where FCHVs delivered the IYCF and the behaviour change components of the programme, and routine MNP distribution was done at local health facilities. This model, ideally, would catalyse opportunities to also deliver other preventive services (e. g. child growth monitoring and vaccination) while mothers were at the health facilities picking up the batches of MNP. Each distribution model was piloted in districts in both the plains and hills ecozones, with the aim of learning how the models would work in different settings.

While no differences by model were observed in initial coverage in the plains 3 months after programme implementation, coverage was higher in the FCHV model among those who had ever heard of the MNP. Fifteen months after programme implementation in the hills, both coverage among the total sample and coverage among those who had heard of the MNP were higher in the FCHV model, and repeat coverage (≥2 MNP batches) among children ≥12 months of age who had received at least one MNP batch was also higher in the FCHV model.

While different districts and ecozones were surveyed at 3 months and at 15 months after programme implementation, collectively, results suggested higher coverage from the FCHV model, as had been predicted. We examined the results limited to those who had heard of MNP because increasing fidelity to implementation of the program package and raising awareness of the intervention among the population are modifiable and aspects a programme can change or improve. The findings limited to those who had heard of MNP suggested the improvements to coverage that might occur as behaviour change strategies are further refined, as populations that might not have been reached are identified and addressed, and as programmes raise awareness of MNP in communities.

While coverage was higher in the FCHV model, initial concerns regarding the added workload to volunteers in the FCHV model were upheld, as a greater proportion of volunteers reported the need for more support or disliked the workload added by the IYCF/MNP program in both the 3- and 15-month surveys. These differences were not statistically significant, which may be because of small sample sizes. After the pilot period ended, the decision was made by the Nepal government for MNP distribution to be done routinely both at health facilities and by volunteers in communities, in order to help reduce some of the workload of FCHV while also keeping MNP conveniently available in communities. This

type of combined distribution has been used effectively in other public health strategies; for example, vitamin A supplementation often combines routine and campaign distribution (Aguayo *et al*. 2007), and health facility outreach is carried out for multiple interventions with the aim of providing services to those with less access to or otherwise do not go to health facilities (Palmer *et al*. 2013).

The behaviour change strategies in this intervention included multiple activities; some strategies were associated with increased odds of initial or repeat coverage, suggesting that it may be important to prioritise and strengthen those as the intervention matures or expands to new districts. When designing the intervention, it was expected that most mothers in communities would initially attend a mothers' group meeting launching the new integrated IYCF/MNP intervention. The prevalence of mothers who reported attending a mothers' group meeting where MNP was discussed was lower than expected (10–29% in the 3-month surveys, 13–15% in the 15-month surveys). However, those mothers who attended a mothers' group meeting had increased odds of MNP coverage in both models in the 3-month surveys, as well as increased odds for repeat coverage in the HF model at the 15-month survey. Ensuring that FCHVs regularly discuss MNP at meetings or holding additional meetings at more convenient times or locations to add opportunities for attendance may be useful ways to support and motivate increased coverage. Such activities may also enable more mothers to hear about MNP in the community overall, even if they are unable to attend the meetings. Similarly, efforts to increase the number of mothers who hear the MNP radio advertisements might improve initial coverage, as this was a significant predictor of coverage in the FCHV model in the 3-month survey.

The long duration of preventive MNP interventions is a challenge to programmes as salience and motivation among participants for any intervention is likely to decline over time (World Health Organization 2003). Among those with repeat coverage, a large proportion (90% FCHV model, 69% HF model) said they were reminded to go back and get the next batch of MNP. This suggests that personal prompts by intervention delivery staff or family members could also support coverage and increase the salience of the MNP intervention over time. At the 15-month surveys, mothers reported that the staff members assigned to distribute MNP in each model (either FCHV in the FCHV model or health facility staff in the HF model) were more likely to remind mothers to get the next batch of MNP, suggesting that staff being assigned to distribute MNP may increase the likelihood of their prompting mothers. Better understanding what behaviour change strategies effectively increase coverage across delivery platforms and settings is an implementation research priority.

In both models in the 15-month survey, mothers who perceived one or more positive effects of MNP in their children had increased odds of obtaining additional batches of MNP. Frequently reported positive effects in children in these districts included increasing a child's energy and appetite, as well as making a child healthier and stronger. These positive outcomes are not reported in the WHO guideline or related systematic review (World Health Organization 2011; De-Regil *et al*. 2011) and building the evidence base related to these salient effects is encouraged so that programmes can refer to an evidence base when promoting or explaining the rationale for MNP use. Other studies have identified that maternal observation of tangible MNP effects in children is a compelling and motivating

factor in support of MNP use (Jefferds *et al*. 2010; dePee *et al*. 2013), and appropriately framing such positive effects in behaviour change strategies is critical to support coverage.

We identified several disparities in those reached with MNP coverage. Younger children had lower odds of initial or repeat coverage compared with older children. The design of the intervention was for children to enter the programm routinely as soon as they were eligible at 6 months of age, but we observed delays in newly eligible children obtaining MNP. This age disparity occurs in other public health programs as well. For example, so that children can receive vitamin A supplementation as soon as they are eligible, programs have tested multiple innovations, including sending text messages to families when the child turns 6 months of age (Thiaw *et al*. 2014), adding a 6-month contact point into the vaccination calendar (Nyhus 2014), adding or changing delivery sites, and increasing efforts toward social mobilisation and behaviour change (UNICEF 2007, Aguayo *et al*. 2007). These strategies may also improve MNP coverage among younger children.

As is common throughout the Indian subcontinent, there is a cultural preference for boys in Nepal, and women generally have a lower social status compared with men (Leone *et al*. 2003; Furuta & Salway 2006). Girls had half the odds of MNP coverage that boys did in the HF model collected 3 months after implementation in the Parsa district, but there was no evidence of a sex bias in the FCHV model or in repeat coverage in the HF model collected 15 months after implementation in the Makwanpur district. A potential sex bias was examined but not identified as a problem during the formative research phase to develop the intervention or from internal monitoring sources during implementation of the pilot project. In the HF model, families had to travel to the health facility to get a batch of 60 MNP for their children, and may have been less willing to travel for daughters as for sons. The revised post-pilot distribution model that distributes MNP through health facilities and FCHV may help resolve this potential sex bias, but monitoring MNP coverage by child sex should remain a priority.

This analysis has several strengths. The data are population based and representative of children 6–23 months of age living in rural areas of the four districts included in the pilot intervention. It uses data collected in varied real-world settings, and describes programme factors associated with improved coverage in different delivery models, which fills a critical implementation evidence gap not reported in the efficacy literature (De-Regil *et al*. 2011; dePee *et al*. 2013). Data were collected from both mothers and volunteers involved in the intervention, for better understanding of factors influencing the effectiveness and feasibility of the delivery models. Also, data were collected at two time points, shortly after the intervention start when project investments and expectations were high, and 15 months after the program start when activities had become more routine and might better reflect regular ongoing performance.

Limitations include that data are cross-sectional and self-reported, and that some findings might reflect reverse causality (e. g. those who obtained MNP might be more likely to report having heard of MNP or heard the radio advertisement, more likely to travel to get MNP, or better positioned to improve their children’s nutrition and health). While we examined proxies of exposure to the full intervention package and specifically indicators likely to

influence the knowledge, skills and motivation of mothers to get batches of MNP, we were not able to include in the regression models indicators that directly measured the quality of intervention delivery for specific components (e. g. the health care worker or FCHV interaction and communication to mothers when distributing MNP sachets, or the FCHV led mothers' group meeting where IYCF/MNP programme was introduced with the flip chart teaching aid). Other internal monitoring data not presented here suggest that the quality of delivery for both rural models was usually adequate during the pilot. Underlying differences between ecozones and districts, such as in maternal or FCHV education, socio-economic status of families, or number of years worked as a FCHV, might have influenced the results reported for each of the models. Because each model was evaluated in only one district per time period, district characteristics cannot be disentangled from the delivery model; if those characteristics were also associated with coverage, comparison of the two delivery models might have been affected. District-specific data are not available; however, locale-specific differences in FCHV performance may be minimal (Ministry of Health and Population Nepal, New ERA & ICF International Inc 2012). For example, FCHV distribute vitamin A supplements and the most recent coverage data were 87–89% from the four sub-regions where this pilot project was located. Further, all models in the current study controlled for maternal education and wealth quintile.

Our findings may be useful for other programmes as they design their distribution model(s) and behaviour change strategies. Of particular use may be consideration of the disparities identified in these analyses, such as differences in access to MNP related to child's age and sex, as well as which strategies were (and were not) associated with coverage and repeat coverage in a programmatic public health setting. A primary aim of piloting possible delivery approaches for an MNP intervention is to understand which approaches are feasible and can also achieve and sustain the highest coverage across the intervention sites. A single delivery model or channel may not be sufficient to effectively achieve sustained high coverage due to variations in infrastructure, resources, distances, health burden, or other contextual factors, and a combination of delivery approaches might be needed.

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Key messages

- More than 40 countries implement micronutrient powder (MNP) interventions, but there is little documentation of the predictors of MNP coverage for different MNP delivery models in varied settings.
- Distribution of MNP by volunteers within communities resulted in higher coverage compared with distribution at health facilities in rural areas, but volunteer burden is important to consider.
- Prioritising and strengthening promising behaviour change strategies may improve initial and repeat coverage.

Table 1

Characteristics of the survey population, 3 months after programme implementation, Rupandehi and Parsa districts in the plains ecozone of Nepal, 2011

Characteristic	FCHV model* (%)	HF model† (%)	*P*-value
Total survey population	*n* = 360	*n* = 336	
Child's age (months)			
6–11	30.8	28.0	0.41
12–17	40.8	46.1	
18–23	28.3	25.9	
Male child	52.5	49.4	0.44
Mother's education			
No education	35.0	66.7	<0.001
Primary level‡	28.9	21.1	
Secondary level or higher§	36.1	12.2	
Wealth quintile			
Lowest/second lowest	28.6	43.2	<0.001
Middle	22.2	33.3	
Highest/second highest	49.2	23.5	
Mother reports ≥1 consequence of anaemia	27.2	45.2	0.008
Mother heard of MNP	75.0	83.3	0.09
Coverage of 60 MNP sachets	65.0	57.4	0.19
Child consumed any MNP	64.4	57.1	0.20
Attended mothers' group meeting where MNP discussed	9.7	28.9	<0.001
Heard MNP radio advertisement	8.3	12.5	0.19
Among those who had heard of MNP	*n* = 270	*n* = 280	
Coverage of 60 MNP sachets	86.7	68.9	<0.001
MNP reported easily accessible	91.1	76.1	<0.001

FCHV, female community health volunteer; HF, health facility; MNP, micronutrient powder.

*Representative of households with children 6–23 months of age in rural areas of Rupandehi district, plains ecozone.

†Representative of households with children 6–23 months of age in rural areas in Parsa district, plains ecozone.

‡Primary level includes classes 1–5, adult classes and informal education.

§This level includes classes 6–10 and higher.

Table 2

Prevalence and odds of coverage of receiving a batch of 60 MNP by socio-demographics and intervention exposures, 3 months after programme implementation, Rupandehi and Parsa districts in the plains ecozone of Nepal, 2011

Item	FCHV model*				HF model†			
	n	%	aOR‡	95% CI	*n*	%	aOR‡	95% CI
Total	360	65.0			336	57.4		
Child age (months)								
6–11	111	35.1	1.00	–	94	38.3	1.00	–
12–17	147	78.2	9.93	4.61–21.39	155	68.4	3.92	2.01–7.61
18–24	102	78.4	9.84	5.11–18.93	87	58.6	3.10	1.77–5.44
Child sex								
Male	189	66.7	1.00	–	166	63.9	1.00	–
Female	171	63.2	0.71	0.38–1.32	170	51.2	0.54	0.37–0.79
Attended a mothers' group meeting§								
No	325	61.8	1.00	–	239	48.5	1.00	–
Yes	35	94.3	20.12	6.03–67.16	97	79.4	5.28	2.55–10.95
Heard the MNP radio advertisement								
No	330	62.4	1.00	–	294	55.4	1.00	–
Yes	30	93.3	5.13	1.13–23.28	42	71.4	1.37	0.70–2.67
Knew ≥1 anaemia consequence								
No	262	59.9	1.00	–	184	51.1	1.00	–
Yes	98	78.6	2.81	1.51–5.23	152	65.1	1.43	0.80–2.56

FCHV, female community health volunteer; HF, health facility; MNP, micronutrient powder.

*Representative of households with children 6–23 months of age in rural areas of Rupandehi district, plains ecozone.

†Representative of households with children 6–23 months of age in rural areas in Parsa district, plains ecozone

‡Models adjusted for maternal education and wealth quintile.

§Attended a FCHV-led mothers' group meeting where MNP was discussed.

Table 3

Characteristics of the survey population 15 months after implementation start and by sub-sample of those with a child ≥12 months of age who received ≥1 batch of 60 MNP, Palpa and Makwanpur districts in the hills ecozone of Nepal, 2011

	Total sample			Children >12 months and received >1 MNP batch		
	FCHV model* (%)	HF model† (%)	*P*-value	FCHV model‡ (%)	HF model§ (%)	*P*-value
Total survey population	*n* = 309	*n* = 347		*n* = 193	*n* = 136	
Age of children (months)						
6–11	30.1	34.0	0.13	–	–	
12–17	42.7	34.9		59.6	43.4	<0.001
18–23	27.2	31.1		40.4	56.6	
Male children	50.8	50.4	0.93	51.8	54.4	0.64
Education of mother						
No education	11.7	36.0	<0.001	12.4	30.1	<0.001
Primary level¶	36.2	41.5		36.3	41.9	
Secondary level or higher**	52.1	22.5		51.3	27.9	
Wealth quintile						
Lowest/second lowest	54.0	68.3	0.06	49.7	60.3	0.36
Middle	23.0	15.9		25.9	19.9	
Highest/second highest	23.0	15.9		24.4	19.9	
Mother reported ≥1 anaemia	52.1	62.8	0.15	49.2	59.6	0.20
Mother heard of MNP	91.3	74.1	<0.001	100	100	††
MNP coverage	82.5	51.6	<0.001	100	100	††
MNP coverage, ≥2 batches	‡‡	‡‡		51.8	35.3	0.05
Child consumed any MNP	82.5	51.6	<0.001	100	100	††
Attended mothers' group meeting where MNP discussed	14.9	13.3	0.64	83.4	77.2	0.24
Heard MNP radio advertisement	31.1	36.0	0.37	36.3	50.0	0.02
Among those who heard of MNP	*n* = 282	*n* = 257		*n* = 193	*n* = 136	
Coverage	91.1	69.6	<0.001	100	100	††
MNP reported easily accessible	95.4	76.3	<0.001	99.5	92.6	<0.001

aOR, adjusted odds ratio; FCHV, female community health volunteer; HF, health facility; MNP, micronutrient powder.

*Representative of households with children 6–23 months in rural areas in Palpa district, hills ecozone.

[†]Representative of households with children 6–23 months in rural areas in Makwanpur district, hills ecozone.

[‡]Households with children 12–23 months and who received at least one batch of 60 MNP sachets, rural areas in Palpa district.

[§]Households with children 12–23 months and who received at least one batch of 60 MNP sachets, rural areas in Makwanpur district.

[¶]Primary level includes classes 1–5, adult classes, and informal education.

[**]This level includes classes 6–10 and higher.

[††]*P*-values not calculated.

[‡‡]Not analysed among entire population as only those ≥12 months, who had received ≥1 MNP batch were eligible.

Table 4

Prevalence and odds of coverage of >2 batches of 60 MNP among mothers with children ≥12 months of age who previously obtained one batch of 60 MNP, 15 months after program implementation, Palpa and Makwanpur districts in the hills ecozone of Nepal, 2011

	FCHV model*				HF model†			
	n	**%**	**aOR‡**	**95% CI**	***n***	**%**	**aOR‡**	**95% CI**
Total	193	51.8			136	35.2		
Age (months)								
12–17	115	41.7	1.00	–	59	27.1	1.00	–
18–24	78	66.7	3.01	1.47–6.18	77	41.6	3.75	1.55–9.07
Sex								
Male	100	50.0	1.00	–	74	36.5	1.00	–
Female	93	53.8	1.25	0.71–2.17	62	33.9	1.40	0.56–3.51
Attended a mothers' group meeting§								
No	161	49.1	1.00	–	105	26.7	1.00	–
Yes	32	65.6	1.30	0.38–4.48	31	64.5	6.79	2.23–20.69
Heard the MNP radio advertisement								
No	123	48.0	1.00	–	68	35.3	1.00	–
Yes	70	58.6	1.52	0.76–3.01	68	35.3	0.67	0.23–1.91
Knew ≥1 consequence of anaemia								
No	95	47.4	1.00	–	81	29.6	1.00	–
Yes	98	56.1	1.24	0.50–3.12	55	43.6	1.82	0.51–6.47
Received brochure								
No	103	45.6	1.00	–	57	24.6	1.00	–
Yes	90	58.9	2.13	0.90–5.02	79	43.0	2.68	0.68–10.58
Received reminder card								
No	53	54.7	1.00	–	25	24.0	1.00	–
Yes	140	50.7	0.49	0.22–1.10	111	37.8	0.69	0.21–2.21
Perceived ≥1 negative effect								
No	126	52.4	1.00	–	70	40.0	1.00	–
Yes	67	50.7	1.09	0.52–2.30	66	30.3	0.91	0.31–2.71
Perceived ≥1 positive effect								

	FCHV model*				HF model†			
	n	%	aOR‡	95% CI	*n*	%	aOR‡	95% CI
No	86	31.4	1.00	–	59	13.6	1.00	–
Yes	107	68.2	4.02	1.77–9.10	77	51.9	5.99	1.42–25.16
Child did not like MNP								
Not reported	111	60.4	1.00	–	68	45.6	1.00	–
Reported	82	40.2	0.60	0.25–1.46	68	25.0	0.93	0.25–3.44
Round-trip time								
<1 h/delivered	139	53.2	1.00	–	30	43.3	1.00	–
≥1 h	54	48.1	0.82	0.31–2.21	106	33.0	0.45	0.12–1.62

aOR, adjusted odds ratio; FCHV, female community health volunteer; HF, health facility; MNP, micronutrient powder.

*Representative of households with children 6–23 months in rural areas in Palpa district, hills ecozone.

†Representative of households with children 6–23 months in rural areas in Makwanpur district, hills ecozone.

‡Controlled for maternal education and wealth quintiles.

§Attended a FCHV-led mother's group meeting where integrated feeding/MNP intervention was discussed.

Table 5

FCHV characteristics and experiences with the IYCF/MNP pilot programme 3 and 15 months after implementation, Nepal 2011

	3 months			15 months		
	FCHV model*	HF model†	*P*-value	FCHV model‡	HF model§	*P*-value
Total, *n*¶	67	29		29	34	
Age, mean	43.5	41.5	0.40	41.1	35.7	0.05
No education, %	47.8	72.4	0.05	13.8	35.3	0.05
Years as FCHV, mean	14.4	10.8	0.01	13.9	7.9	<0.001
FCHV work previous week, mean # days	2.5	3.4	0.01	3.2	3.5	0.42
Average ≥5 h per day on FCHV duties on days worked as FCHV, %	34.3	10.3	0.02	20.7	23.5	0.79
Discussed MNP with ≥1 mother previous week, %	76.1	96.6	0.02	69.0	76.5	0.50
More support needed for workload/do not like workload added, %	23.9	10.3	0.13	56.5	43.5	0.20

FCHV, female community health volunteer; HF, health facility; MNP, micronutrient powder.

*FCHVs working in rural areas in Rupandehi district, 3 months after implementation start, plains ecozone.

†FCHVs working in rural areas in Parsa district, 3 months after implementation start, plains ecozone.

‡FCHVs working in rural areas in Palpa district, 15 months after implementation start, hills ecozone.

§FCHVs working in rural areas in Makwanpur district, 15 months after implementation start, hills ecozone.

¶Sample sizes might vary slightly due to missing data.